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INSIGHT SEMINAR: Fundamentals and applications of free space diffuse irradiance collimation for enhancing photovoltaic yield

REBECCA SAIVE

February 27, 2025
12:00 to 13:00
Elements Room and Online (Teams)

ABSTRACT:
In many photovoltaic applications, particularly in urban environments, numerous surfaces could theoretically be utilized to capture solar energy; however, installing PV panels on all of them would be inefficient and cost-prohibitive. An economically and environmentally viable solution is to develop purely optical materials that can redirect incident sunlight to nearby PV systems. Conventional mirrors would require tracking, only work under direct irradiance conditions, and create hotspots which can lead to fire hazards. On the other hand, ideal diffuse reflectors, i.e., white surfaces scatter light into all directions and a majority of the light

misses the panel.
This work explores the design and application of an optical metamaterial that enables redirection of diffuse irradiance toward PV panels without the need for tracking systems. We achieve this with free-space luminescent solar concentrators (FSLSCs). These devices employ polymer waveguides embedded with luminophores, featuring a Lambertian rear reflector for photon recycling and randomization, along with a spectro-angular notch filter that allows light to be accepted from all angles while directing down-converted light into a targeted escape cone. The result is a collimated beam of 'cold photons'-photons whose energy is just above the solar cell's bandgap, minimizing thermal losses amongst other advantages.
We will present the fundamental physics of diffuse light collimation, and show various application scenarios and their corresponding PV yield improvements. Notably, our results show that under certain conditions, winter energy yield can be significantly enhanced.

BIO:
Dr. Rebecca Saive is a Professor of Applied Physics at the University of Twente, Netherlands. Her research focuses on advanced light management techniques for photovoltaic systems, aiming to enhance solar energy conversion efficiency. Dr. Saive's work bridges fundamental physics and applied technology. She earned her PhD from the University of Heidelberg and completed postdoctoral research at the California Institute of Technology. Dr. Saive co-founded a successful startup in the semiconductor sector and was named one of the Innovators Under 35 Europe and Global by MIT Technology Review in recognition of her innovative contributions to solar energy.
Hosted by: Prof. Dr. Georgia Papadakis